

## EE 483L/583L Antennas for Wireless Communications (Spring 2026)

### Laboratory 7- Yagi-Uda Match Design

#### **Background**

For this project, design a modified Gamma match for your Yagi-Uda antenna design of Laboratory 6 **after** any necessary corrections. The goal is for the antenna to have a  $VSWR < 1.1$  at the center frequency and  $VSWR \leq 1.7$  across the frequency band of the UHF television (TV) station when fed using a  $50 \Omega$  coaxial transmission line.

#### **Project**

- 1) Before matching, **tabulate** a summary of your *no boom* antenna design (channel, center frequency, # elements, lengths, spacings, etc.) with driven element length set for *resonance* at  $f_c$ . At the low  $f_p$ , center  $f_c$ , and high  $f_h$  frequencies (columns) of the selected UHF TV channel, find & **tabulate** (rows) input impedance  $Z_{in} = Z_a$  (rectangular format) & reflection coefficient  $\Gamma_{in}$  (polar format), VSWR, mainbeam  $G_{max}$  & backlobe  $G_{back}$  gains (dBi), and front-to-back ratio/FB (dB).
- 2) At  $f_c$ , design a **modified Gamma match** for your Yagi-Uda antenna **without the boom**, i.e., NO boom length compensation & NO boom in NEC-2 model. At each step, detail & comment on design choices, e.g., what are you changing/selecting, values, and why. **SHOW ALL WORK\***. **Tabulate** a summary of your starting and final designs (similar to step 1 with addition of match). (\* For brevity, you can omit obviously wrong steps in report.)
  - For design/modeling purposes, assume the elements and modified Gamma match are made of commercially-available brass ( $\sigma_{brass} = 1.1 \times 10^7$  S/m) pipes.
  - Put antenna on the  $y$ - $z$  plane ( $x = 0$ ) with the elements parallel to the  $y$ -axis, reflector centered on origin, and driven & director elements spaced along positive  $z$ -axis.
  - Let the modified Gamma match portion of the driven element (modeled as wire of equivalent radius  $a_e$ ) start at  $y = 0$  and go to  $y = l'/2$ . To attempt to partially account for the use of a boom on a physical antenna, place the feed at the **second segment** out from  $y = 0$  on the modified Gamma match portion of the driven element. Make  $\Delta \leq 1$  cm and use the EK 0 command in NEC-2 model.
  - Calculations, input NEC-2 file(s), and relevant excerpts of output file(s) should be **included** in logbook as used. Modeling/matching choices should be explained and justified (e.g., selection of segment length  $\Delta$ ). For the report, it is acceptable to summarize the **initial** matching iterations/steps (i.e., list what items were selected/changed and results) without calculations, NEC-2 input file, & NEC-2 output excerpts so long as proper reference to logbook is made. The calculations, NEC-2 input file, & NEC-2 output excerpts for the **final** iteration **should** be included in the report.
- 3) Write a NEC-2 input file to find  $Z_a$ ,  $G_{max}$ , and  $G_{back}$  for your matched antenna at  $f_p$ ,  $f_c$ , &  $f_h$ . Calculate the FB ratio,  $Z_{in}$ ,  $\Gamma_{in}$  (polar format), and VSWR at each frequency. For these frequencies (columns), **tabulate**  $Z_{in}$ ,  $\Gamma_{in}$ , VSWR,  $G_{max}$ ,  $G_{back}$ , and FB ratio (rows). How they compare to the un-matched antenna? Comment on VSWR at the band edges. Does it meet the specifications?

- 4) Using Fig 10.26 (include in logbook/report), compute the boom compensation at  $f_c$ . Assume the boom diameter  $D$  is 5/8" (outer diameter for 1/2" copper pipe). Apply the full boom compensation to the element lengths found after steps 1 & 2. Apply half the boom compensation to the modified Gamma match length. **Tabulate** the resulting lengths  $l_i$ , spacings  $s_{ij}$ , & diameters  $2a$  of the elements as well as length  $l'/2$ , spacing  $s$ , and diameter  $2a'$  of the modified Gamma match. The table should have three columns- col. 1 is variable description/label, col. 2 is values (cm) *before* boom compensation, and col. 3 is values (cm) *after* boom compensation.
- 5) Accurately draw the resulting antenna with the modified Gamma match and boom. Include all relevant dimensions (cm). Offset your modified Gamma match by  $D/2 + \Delta y$  to avoid overlapping the boom. Assume  $\Delta y = 2$  mm (slightly larger than the center conductor to shield spacing for a typical  $50 \Omega$  coaxial transmission line). The modified Gamma match should be placed between the driven and reflector elements.
- 6) Summarize and comment on results.

**Report** (You may work in teams planning to build antenna.)

- Show complete initial rough work in logbook.
- Following syllabus guidelines, compose a short report on this lab.

**Report & logbook due Wednesday, April 8, 2026 at class.**